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OBSERVATIONS OF A MECHANISM BY WHICH SELF-POLLINATION MAY OCCUR IN *EULOPHIA* (ORCHIDACEAE)

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Abstract

Observations in live plants of a mechanism by which self-pollination may be affected in eight species of *Eulophia* from Zambia, South Central Africa, is reported on. This mechanism is illustrated in seven species and only discussed in the eighth. The illustrations were made from live specimens except for Figs 1A and 1B.

Uittreksel

WAARNEMINGS VAN 'N MEGANISME WAARVOLGENS SELFBESTUIWING BY *EULOPHIA* (ORCHIDACEAE) MAG VOORKOM

Waarnemings by lewende plante van 'n meganisme waarvolgens selfbestuiwing in agt *Eulophia*-species vanaf Zambia, Suid-Sentraal Afrika, word verslag oor gedoen. Die meganisme word by sewe species illustreer en slegs by die agste beskryf. Die illustrasies is van lewende eksemplare gemaak behalwe figure 1A en 1B.

Key words: *Eulophia*, Orchidaceae, Zambia, self-pollination.

Introduction

Very little work has been done on the pollination biology and breeding systems of tropical African orchids. Williamson has commented on and illustrated autogamy in various genera (1977, 1979, 1980). Gassner (1982) has published a short account of self-pollination in *Disa stolzii* Schltr. = *Disa erubescens* Rendle subsp. *carsonii* (N. E. Br.) Linder. Cribb and Gasson (1982) recorded unusual asexual (vegetative) reproduction in *Cynorkis uncata* (Rolfe) Kraenzl. from East Africa.

Charles Darwin (1904) repeated an observation made by Dr Crüger on three plants from Trinidad "it is easily seen that the pollen-masses ha[illegible] been acted on by the stigmatic fluid, and that the pollen tubes descend from the pollen-masses in situ down into the ovarian canal." This observation made in 1864 is almost identical to the observations recorded in this paper on autogamy in African *Eulophia* species.

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During work on the orchids of Zambia over two decades numerous field observations on self-pollination were made on several different genera. Observations made on *Eulophia* species are reported on in this paper.

OBSERVATIONS

At a certain level of maturity of the flowers, the pollinia become active and outgrowths begin to appear from the lower border of the pollinia. These growths take on various forms. In *E. farcta* Williamson, the growths are cylindrical and grow towards the stigma completely covering the viscidium and rostellum until the stigma is reached (Fig. 1.1A). The growths in *E. saxicola* Cribb & Williamson are large and spherical lifting the anther cap and becoming fused to the cap base (Fig. 1.2A).

In *E. nyassae* Rendle, the outgrowths tend to be rather narrow and were seen to penetrate the rostellum on their way to the stigma. Fig. 1.3 shows part of the rostellum dissected away where the outgrowth was removed illustrating the growth penetration. *Eulophia ecalcarata* Williamson (Fig. 1.4) displayed very large outgrowths which tended to bypass the viscidium and then curve backwards over the rostellum to contact the stigma. The pollinia plus the outgrowths are shown in Fig. 1. 4C.

Eulophia katangensis (De Wild) De Wild (Fig. 1.5) was observed to have the same outgrowth pattern as in *E. farcta* but the viscidium was obsolete in many flowers; however the pollinia were always joined by the caudicles (Fig. 1. 5B). *Eulophia penduliflora* Kraenzl. (Fig. 1.6) displays what might be a more efficient mechanism. The pollinia have no viscidium, stipe or caudicles and lie very low down at the base of and below the androclinium. The rostellum shelf is deeply cleft and tends to curve around the pollinia. A small amount of shiny, stigmatic tissue (Fig. 1.6A, se) projects into the base of the androclinium through the rostellum cleft. The pollinia become fused to the base of the anther cap (Fig. 1, 6 C, p) and small pollen outgrowths appear (Fig. 1, 6C, p g). The pollinia lie in virtual aposition to the stigma, thus unlike in *E. ecalcarata* the pollen growths almost immediately touch the stigmatic surface.

Eulophia acutilabra Summerh. (Fig. 1.7) displays yet again a further variation. The pollinia lie below the main portion of the androclinium, even in normal flowers (Fig. 1. 7A, p) and are attached to the viscidium by a much reduced stipe (Fig. 1. 7C). In the flowers where self-pollination appears to take place the viscidium and stipe are completely absent. As in *E. penduliflora* the pollen outgrowths have a very short distance to grow before coming into contract with the stigmatic surface (Fig. 1. 7B, p g). This phenomenon has also been observed in live plants of *E. macaulayae* Summerh. (not illustrated) where the anther cap becomes fused to the androclinium and the pollinia hypertrophy and overflow on to the stigmatic surface.

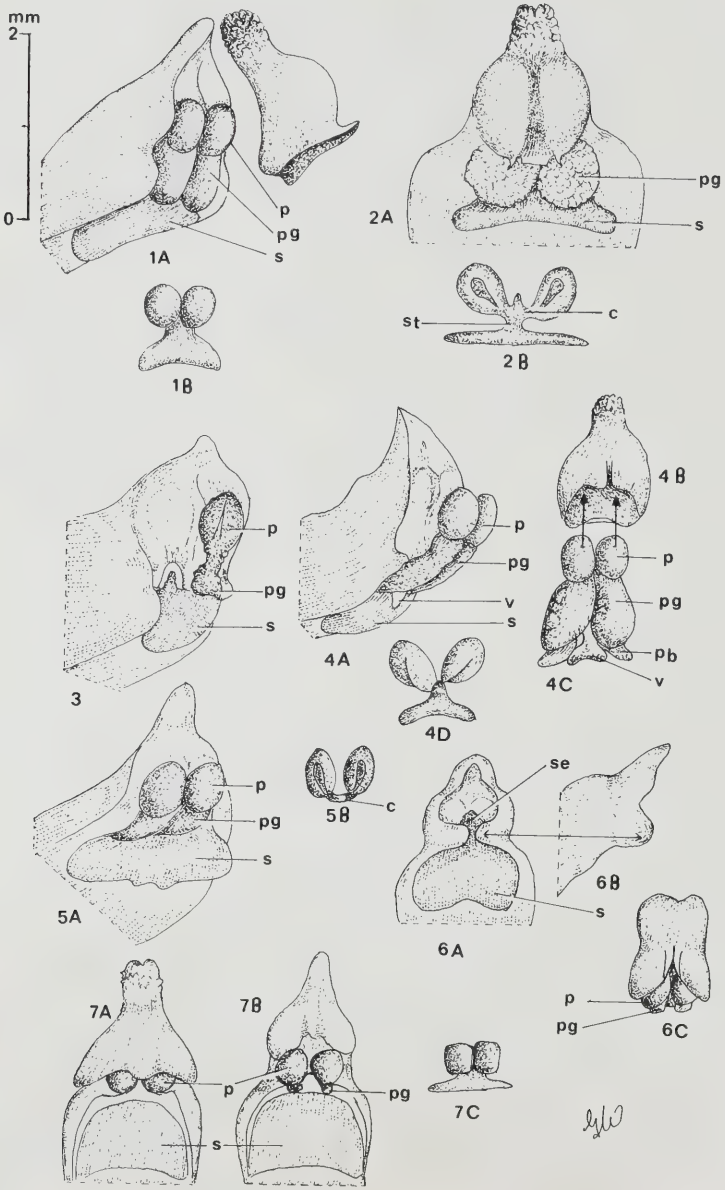
The rostellum in the species under discussion is usually a narrow shelf separating the base of the androclinium from the anterior border of the stigma. It is possible that the central portion of the rostellum contains some stigmatic tissue. Dressler (1981) suggests that in orchid self-pollination, the rostellum may function as part of the stigma. The pollinia are located loosely within the base of the anther cap. The posterior portion of the base of the cap lies between the pollinia and the androclinium and is usually split (Fig. 1. 4B and 6C). The upper third of the caps are solid and the apices are occasionally lightly papillose to verrucose.

DISCUSSION

Although capsules were seen to be present on most of the *Eulophia* species studied, except for *E. ecalcarata*, it was not noted that these capsules were actually produced from the flowers where self-pollination took place. A colony of *E. ecalcarata*, close to Lusaka, was observed periodically over a period of eight years and some of the capsules were certainly produced from flowers where the self-pollinating mechanism took place (Williamson, 1980). However, neither in this *Eulophia* or any of the other *Eulophia* species, was the fertility of the seed verified. Darwin (1905) observed that although a self-fertilized capsule of *Cattleya crispa* contained an abundance of seeds, on examination only about one per cent contained an embryo. Until proved otherwise this could well be the case in the Zambian *Eulophia* species.

During discussions with Prof. A. V. Hall of the Bolus Herbarium, the possibility of these pollen outgrowths being aberrant and abnormal was considered. This would seem unlikely due to the number of species in which autogamy was observed. Self-pollination may be an adaptation to the prevailing physical and population biological perimeters within which these species exist. Dressler (1981) stated that self-pollination has a clear advantage where a plant species is extending itself beyond the geographic range of its usual pollinator.

All the *Eulophia* species discussed occur in *Brachystegia-Julbernadia* woodland known locally as miombo (Wild & Grandvaux Barbosa, 1967). A few species occur on rock islands within the miombo [*E. saxicola* (Cribb, 1977) almost always and *E. ecalcarata* and *E. penduliflora* frequently]. Most of the species flower before the rains begin or into the early rain period, the time of maximum firing of the miombo. Due to fire, intensive cultivation and general degradation of the habitat by anthropogenic factors, all the species are rare and except for *E. ecalcarata* only occur as single plants. Some early flowering miombo Zambian species are becoming restricted to rock outcrop islands possibly because here the effects of fire and especially cultivation are minimal. Usually only one or two flowers open at a time on any one inflorescence. Due to habitat degradation, natural pollinating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agents are probably diminishing. Thus it is possible that these miombo species are more recently evolved or perhaps are still evolving towards autogamy due to a reduction in pollinators. Downing & Gibbs Russell (1981) also link lack of pollinators to anthropogenic factors. They found that orchids were virtually absent from the Umfolozi Game Reserve in Natal and suggest that this is due to the inhibition of sexual reproduction by elimination of insect pollinators as a result of extensive spraying of insecticide during anti tse-tse fly campaigns.

It is interesting to note that all the *Eulophia* species exhibiting this self-pollinating mechanism possess rather small inconspicuous flowers with two species saprophytic with greenish flowers. One of these, *E. ecalcarata*, has no spur and in *E. farcta* the vestigial spur is solid (Williamson, 1980). In both these species almost every flower produces a capsule (Williamson, 1980). Dressler (1981) notes that self-pollination is frequent in saprophytes. A further early flowering miombo *Eulophia* species, *E. williamsonii* Cribb, is evolving towards an obsolete viscidium but the pollinia are joined by the caudicles (Cribb, 1977). However, autogamy has not been observed in this species. A similar self-pollinating mechanism has also been observed in *Pteroglossaspis corymbosa* Williamson (Williamson, 1979) and in a plant of *Oeceoclades quadriloba* (Schltr.) Garay and Taylor collected by *S. Marvi 1055* (BOL) from Chibi in Zimbabwe.

Self-pollination has not been observed in *Eulophia* species growing under higher rainfall conditions or where effective humidity is high, generally in wet grasslands or in dambo conditions (bogs) where there is perennial seepage. Unlike the miombo habitat which is a fire climax habitat (D. B.

FIG. 1.

1, *Eulophia farcta*; 1A, Column apex with anther cap lifted, $\frac{3}{4}$ side view; 1B, normal pollinarium. 2, *E. saxicola*; 2A, apex of column with anther cap in place, $\frac{3}{4}$ view; 2B, normal pollinarium. 3, *E. nyassae*, apex of column with anther cap removed and one pollen outgrowth dissected out, $\frac{3}{4}$ side view. 4, *E. ecalcarata*; 4A, apex of column with anther cap removed, pollinia have been lifted away from the androlonium, $\frac{3}{4}$ side view; 4B, anther cap posterior view; 4C, pollinarium plus pollen outgrowths removed from the androclinium; 4D, normal pollinarium. 5, *E. katangensis*; 5A, apex of column with anther cap removed; 5B, normal pollinarium with obsolete viscidium. 6, *E. penduliflora*; 6A, apex of column from $\frac{3}{4}$ below; 6B, apex of column, lateral view; 6C, anther cap from behind with fused pollinia. 7, *E. acutilabra*; 7A, column apex from $\frac{3}{4}$ below with anther cap in place; 7B, column apex from $\frac{3}{4}$ below with anther cap removed showing growth beginning from pollinia; 7C, normal pollinarium. c – caudicle; p – pollinium; pg – pollen outgrowth; s – stigma; se – stigmatic extension; st – stipe; v – viscidium; pb – pollen outgrowths bypassing the viscidium. 1, from *W. D. Holmes 0181* (SRGH, K); 2, from *G. Williamson and R. B. Drummond 1699* (K); 3, from *G. Williamson and B. K. Simon 1793* (SRGH); 4, from *G. Williamson 216* (K, SRGH); 5, from *G. Williamson 1614* (SRGH); 6, from *G. Williamson 1634* (SRGH); 7, from *G. Williamson 1637* (SRGH).

Fanshawe and J. Moss, both formerly Dept. of Forestry, Zambia, pers. comm.) the dambo habitat contains fire tender relict plant communities but due to the perennial seepage is not easily fired. Under dambo conditions *Eulophia* species occur in large colonies and usually possess large showy flowers.

Conclusions

There appears to be an effective method of self-pollination demonstrated in eight species of *Eulophia*. Although no evidence was recorded of fertile seed-set from naturally self-fertilised flowers, it is suggested that this observed mechanism of self-pollination is probably not abnormal. This method of autogamy has been observed in 22% of the species restricted to miombo woodland but is absent from dambo or wet grassland habitats and is possibly an adaptation to the degradation of the miombo habitat.

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